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SOME APPLICATIONS OF THE CREHORE MICROGRAPH, WITH ESPECIAL REFERENCE TO THE RECORDING OF HEART SOUNDS.

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The purpose of this communication is to make a preliminary report of a few methods of using the Crehore micrograph[1] in the study of the physiology of the cardiovascular system in man and in animals.

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[1] Jour. Exper. Med., 1911, xiii, 616; ibid., xiv, 339 to 365, and 520.

Holowinsky[2] was the first to use the principle of light interference rings for the study of the function of the heart, but he used it only for the recording of heart sounds. His instrument is somewhat similar to the Crehore micrograph. He transmitted the sound vibrations electrically from a rather complex transmitter, placed on the chest wall, through an induction coil to an electromagnet actuating a diaphragm to which was attached a mirror in close apposition with a fixed glass plate, as in the Crehore micrograph. As a source of illumination he employed a magnesium light.

Crehore has constructed his instrument for taking two simultaneous photographic records, not, however, of heart sounds, but of the movements of the heart or pulse. He applies a suitable tambour to each of the two sites from which he desires to take tracings, for example, from the apex and from the radial. Each tambour is connected by rubber tubing with one of the interference instruments, which consists of a metal tambour the upper surface of which is formed by a thin brass diaphragm to the centre of which is fastened with colophonium a small mirror, while just above this mirror a glass lens is held stationary. The impulse from the apex beat or pulse is transmitted by the closed column of air through the tubing to the interference instrument where it produces movements of the metal diaphragm and, therefore, of the small mirror. The changes in distance separating the small mirror from the fixed lens above it cause the movements of the light interference rings produced by the rays from a mercury vapor lamp, these rings being photographed through a slit on a moving film.

In working with the Crehore micrograph we have found it necessary to make the following modifications and additions: (1) A time marker; (2) an electromagnetic signal; (3) a modification to permit the taking of more than two simultaneous pulse tracings; (4) an apparatus for taking tracings from the exposed mammalian heart; (5) an adaptation of the micrograph to the recording of heart sounds.

The methods we have used to meet these several deficiencies in the instrument are as follows:

1. *Time Marker.* Crehore estimates time intervals on the film by determining the average speed of the motor propelling the film, before taking each record, and calculating from this the number of inches per second of movement of the film. This method is, of course, accurate only when the film travels at a perfectly even rate, and this we have found not always to be the case. It was, therefore, considered advisable to introduce some more accu-

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[2] Arch. d. physiol. norm. et patholog., 5 Sér., vii, 893; Zeitschr. f. klin. Med., 1901, xlii, 186.

rate form of time measurement. To accomplish this, a tuning fork, electrically activated, and set for twentieths of a second, was attached to the floor close to, but not touching, the micrograph. From its movable end a small cord was stretched to a fixed point on the opposite side of the micrograph in such a way that the cord extended just above, and close to, one of the interference instruments. The cord is placed so that it runs approximately perpendicular to the slit of the camera. When so arranged the vibrating cord causes a distinct sinuous shadow on the moving film, each complete wave representing one-twentieth of a second. This time curve is shown at the bottom of Fig. 1.

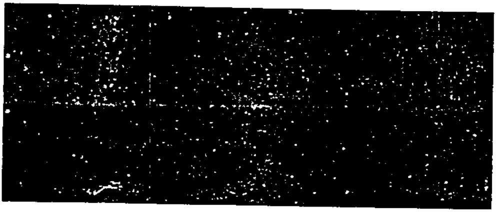

FIG. 1.—Record from right ventricle and jugular of dog. Time curve at bottom—twentieths of a second.

2. *Signal.* The introduction of an electromagnetic signal was accomplished by placing the lever of such a signal just above, almost touching, one of the interference instruments so that its shadow also was thrown through the slit on to the film.

3. *Simultaneous Tracings.* The levers of Marey or other delicate tambours similarly placed permitted the recording of additional pulse tracings or of any other graphic tracings. We have thus taken on one film five simultaneous tracings; the apex tracing on an interference instrument, the radial tracing on the other interference instrument, the carotid tracing with a Marey tambour, a time curve with the tuning fork, and the record of an electromagnetic signal. The ability to take simultaneous tracings from three or more sites has proved often of the greatest assistance in our studies.

4. *Tracing from Exposed Heart.* In taking tracings from the exposed heart it was found that the amplitude of the cardiac movement was so great that the impulse taken directly through a pneumatic tambour held against the heart had too great an amplitude for the sensitive interference instrument. Some method had, therefore, to be devised for reducing this amplitude without altering the character of the curve. It was also desired to localize the tracing to one part of the heart; a tambour held against the

heart gave the movements not only of that part of the heart, but also the changes in position of the heart as a whole. In order therefore, to reduce the amplitude of the pulsation and especially in order to localize the tracing to one part of the heart, we use a modification of the Cushny myocardiograph. This is shown in Fig. 2. It consists simply of the ordinary myocardiograph to which a tambour is attached that can be so placed that the upper end of the movable lever of the myocardiograph shall impinge constantly against the rubber dam, transmitting all its movements to the dam. By raising or lowering the fulcrum of this lever any desired amplitude of movement at its upper end may be secured. The tambour may be connected by tubing, either with one of the interference instruments, or with a Marey tambour, the lever of which is placed to throw its shadow onto the film. This instrument secures both the localization of the tracing to any particular part of the heart, and also the necessary reduction of the impulse amplitude, without, however, impeding the cardiac movement. For securing tracings from exposed vessels we use either a small funnel covered with rubber dam, to the centre of which a small piece of cork is attached, this cork being pressed gently against the isolated vessel, or we introduce a short glass cannula into the vessel, the cannula being filled with saturated magnesium sulphate solution and the end of the cannula away from the vessel being closed with rubber dam. Over this end of the cannula and the dam another rubber tube is drawn containing air, and this, in turn, connected with one of the interference instruments, transmits the movements of the dam to the latter.

5. *Recording of Heart Sounds.* For the recording of heart sounds we first considered the use of telephonic transmission, as in the Holowinsky instrument, but concluded that the record would be freer from adventitious waves if we could secure direct pneumatic transmission. This we have succeeded in doing by making the Crehore interference instrument more sensitive in the following way. One of the interference instruments was taken apart and its metal diaphragm removed. In its place the hard rubber diaphragm from a Bowles stethoscope was substituted, this having been cut to fit the interference instrument. The small mirror was then attached to the centre of this hard rubber diaphragm with colophonium just as it had been attached to the metal diaphragm. The stationary lens was replaced and the adjustment of the rings conducted in the usual manner. The interference instrument thus produced is at least five times as sensitive as the original instrument, and when properly connected with the heart brings out very distinctly the sound vibrations produced by the heart. It is not, however, so sensitive as to be disturbed by the ordinary vibrations of the room. The method of connecting it with the chest is as follows: The instrument is

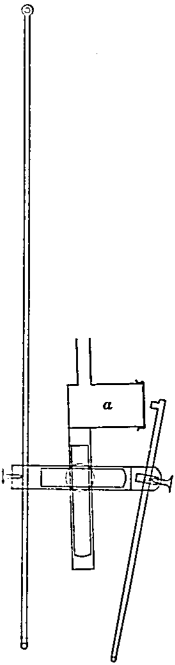

FIG. 2.—Modified Cushny myocardiograph (reduced one-half). *a*, tambour.

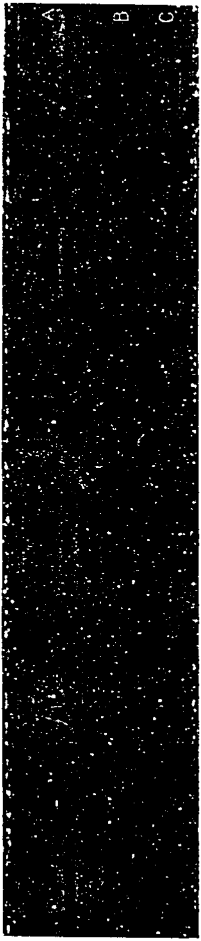

FIG. 3.—Photographic record of normal human heart sounds (*A*), apex tracing (*B*), and time curve (*C*). Tracing represents one cycle.

connected by thick-walled rubber tubing of 3 mm. inside diameter with the chest piece of a Bowles stethoscope. In the course of the tubing one of the air valves belonging to the micrograph is placed. When the chest piece of the stethoscope is applied to the precordium and this air valve left slightly open, the gross shock of the apex beat is not transmitted, while the more rapid vibrations causing the sounds are well transmitted to the interference instrument. The accompanying photograph (Fig. 3), shows such a record, with a simultaneous record of the apex beat recorded from the other unmodified interference instrument by Crehore's method (Fig. 4).

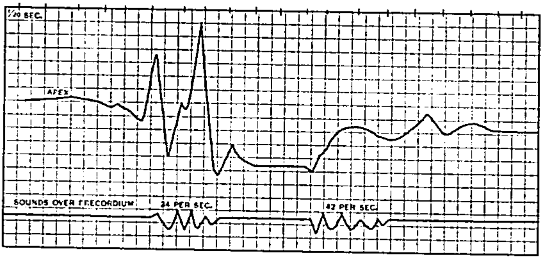

Fig. 4.—Curve plotted from Fig. 3.

Incidentally, it may be mentioned that a mirror fastened at an angle of 45 degrees above the ground glass of the micrograph, enabling the operator while on the floor adjusting the rings to watch, by reflection, the ground glass image of the rings, is a small addition of great service.

These applications to the Crehore micrograph of various forms of physiological apparatus have been found of value in the study of various problems concerning the physiology of the heart and circulation; the results of these studies will be presented in a later communication.

SARCOMA OF THE TONGUE AND CONDITIONS WHICH SIMULATE IT.

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Primary sarcoma of the tongue is a lesion peculiar not only for its rarity but on account of the difficulty in diagnosis in many cases. When the tumor is pedunculated the various forms of